Multiple-Site VMScluster Systems

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This manual provides information about building and configuring VMScluster systems that span sites located in different geographical locations. This manual describes procedures and guidelines for configuring and managing VMScluster systems implemented with the DS3 interconnect.

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Preface

This addendum describes configuration guidelines and system management suggestions for VMScluster systems that encompass multiple nodes located at geographically distant sites.

Who Should Use This Manual

This document is intended for persons responsible for setting up, configuring, and managing VMScluster systems.

How This Manual Is Organized

This documentation addendum contains three chapters.

Chapter 1 provides a brief overview of VMScluster systems that span multiple geographical sites.

Chapter 2 describes how to set up and manage sites using the DS3 interconnect and provides performance goals and requirements.

Chapter 3 provides system management information, including suggested tools and techniques and some monitoring information.

Associated Documents

For additional information on VMScluster topics, refer to the following documents:

- *Guidelines for VMScluster Configurations*
- *VMScluster Systems for OpenVMS*
- VAXcluster Software for OpenVMS VAX *Software Product Description* (SPD 29.78.*xx*)
- VMScluster Software for OpenVMS AXP *Software Product Description* (SPD 42.18.*xx*)

Conventions

The following conventions are used in this manual:

italic text	Italic text emphasizes important information and indicates complete titles of manuals and variables. Variables include information that varies in system messages (Internal error *number*), in command lines (/PRODUCER=*name*), and in command parameters in text (where *device-name* contains up to five alphanumeric characters).
numbers	All numbers in text are assumed to be decimal unless otherwise noted. Nondecimal radixes—binary, octal, or hexadecimal—are explicitly indicated.

1

VMScluster Systems That Span Multiple Sites

This manual discusses multiple-site VMScluster configurations, with an emphasis on the new DS3 communications service. The information in this manual supplements current multiple-site VMScluster discussions in these VMScluster manuals:

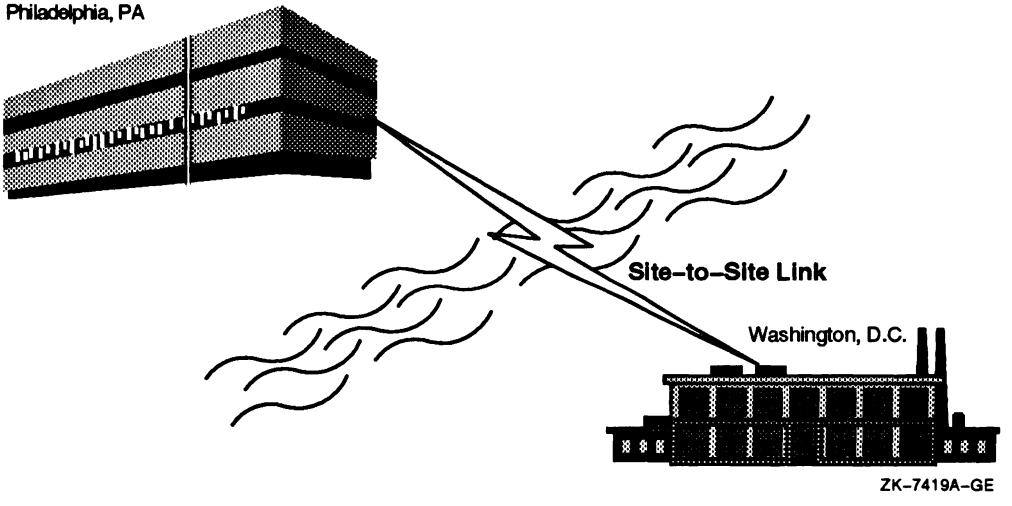
- *VMScluster Systems for OpenVMS*
- *Guidelines for VMScluster Configurations*

This chapter describes multiple-site VMScluster configurations and some of the benefits you can derive from them.

1.1 What Is a Multiple-Site VMScluster System?

A multiple-site VMScluster system has member nodes that are located in geographically separate sites. Figure 1–1 illustrates the concept of a multiple-site VMScluster system for a company with a manufacturing site located in Philadelphia and corporate headquarters in Washington, D.C. This configuration spans a geographical distance of approximately 134 miles (216 km).

Figure 1–1 Site-to-Site Link Between Philadelphia and Washington



This configuration allows a company to locate its VMScluster nodes at sites up to 150 miles (242 km) apart.[1] The sites can share data with the same corporate data center and also benefit because data center operations are managed at a single, centralized location.

[1] The cable route distance between sites.

For example, the Fiber Distributed Data Interface (FDDI) has been in general use since VMS Version 5.4–3 to carry out cluster communications over distances of approximately 25 miles (approximately 40 km).[1]

Since Version 6.1 of OpenVMS VAX and OpenVMS AXP, VMScluster systems also include support for the DS3 communications service. High-performance local area network (LAN) technology combined with the DS3 interconnect allows you to utilize wide area network (WAN) communication services in your VMScluster configuration. VMScluster systems configured with the DS3 interconnect and the GIGAswitch crossbar switch supports nodes located up to 150 miles (242 km) apart.[2] Section 1.3 describes VMScluster systems and the DS3 communications service in more detail.

Note

To gain the benefits of disaster tolerance across a multiple-site VMScluster, use the Business Recovery Server combined with Volume Shadowing for OpenVMS.

Consult your Digital Services Group or see the Software Product Descriptions (SPDs) for complete and up-to-date details about these products.

1.1.1 Benefits of Multiple-Site VMScluster Systems

Some of the benefits achievable with a multiple-site VMScluster system include those described in the following table:

Benefit	Description
Remote satellites and nodes	A few systems can be remotely located at a secondary site and can benefit from centralized system management and other resources at the primary site, as shown in Figure 1–2. For example, a main office data center could be linked via DS3 to a warehouse or a small manufacturing site that could have a few local nodes with directly attached site-specific devices. Alternatively, some engineering workstations could be installed in an office park across the city from the primary business site.
Data center management consolidation	A single management team can manage nodes located in data centers at multiple sites.
Physical resource sharing	Multiple sites can readily share costly devices such as high-capacity computers, tape libraries, disk archives, or phototypesetters.
Remote archiving	Data can be transparently backed up to archival media at the other site as readily as to local media. A system with disks or tape can be located remotely to provide this capability.

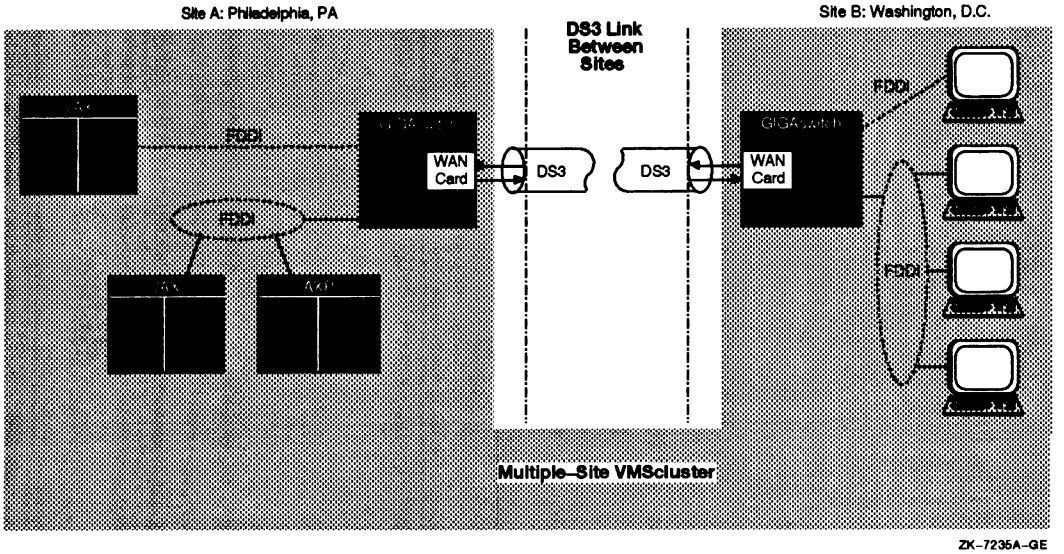
[1] The cable route distance between sites.

[2] The actual distance depends on the physical cable-route distance, not the actual physical miles.

Benefit	Description
Increased availability	In general, a multiple-site VMScluster provides all of the availability advantages of a LAN VMScluster. (See *VMScluster Systems for OpenVMS* for information about LANs.) Additionally, by connecting multiple, geographically separate sites, multiple-site VMScluster configurations can increase the availability of a system or elements of a system in several ways. For example: • Logical volume/data availability—Volume shadowing or redundant arrays of independent disks (RAID) can be used to create logical volumes with members at both sites. Thus, data can be available at the surviving site in the event that one of the sites becomes unavailable. • Site failover— By adjusting the VOTES system parameter, you can select a preferred site to continue automatically when the other site fails or when DS3 communications with the other site are lost. • Disaster tolerance—When combined with the software, services, and management procedures provided by the Business Recovery Server and Volume Shadowing for OpenVMS products, you can achieve a high level of disaster tolerance. The Software Product Descriptions (SPDs) for these products provide further information.

Figure 1–2 shows a VMScluster system with satellites accessible from a remote site.

Figure 1–2 Multiple-Site VMScluster Configuration with Remote Satellites



1.1.2 General Configuration Guidelines

Apply the same configuration rules for VMScluster systems on a LAN to a multiple-site VMScluster configuration that includes an FDDI or a DS3 interconnect. Configuration rules are stated in the following documents:

- VAXcluster Software for OpenVMS VAX *Software Product Description* (SPD 29.78.*xx*)
- VMScluster Software for OpenVMS AXP *Software Product Description* (SPD 42.18.*xx*)

- *Guidelines for VMScluster Configurations*

1.2 Using FDDI to Configure Multiple-Site VMScluster Systems

Since VMS Version 5.4–3, FDDI has been the most commonly used means to connect two geographically distant VMScluster sites. Using high-speed FDDI fiber-optic cables, you can connect sites with a cable-route distance of up to 25 miles or 40 km.

You can connect sites using either of these methods:

- Use a full-duplex FDDI link at 100 Mb/s both ways between GIGAswitch bridges at each site for maximum performance.
- Use a dual FDDI ring at 100 Mb/s between dual attachment stations (DAS) ports of wiring concentrators or GIGAswitch bridges for maximum link availability.

Refer to the *GIGAswitch/FDDI ATM Linecard Reference Manual* (order number EK-GAGL2-RC) for configuration information. Also, refer to the following Digital manuals for additional VMScluster configuration guidelines and system management:

- *Guidelines for VMScluster Configurations*
- *VMScluster Systems for OpenVMS*

The inherent flexibility of VMScluster systems and improved VMScluster LAN protocols also allow you to connect multiple VMScluster sites using the DS3 communications services. The remainder of this document describes how you can bridge an FDDI interconnect to the DS3 communications service.

1.3 Using DS3 to Configure Multiple-Site VMScluster Systems

With OpenVMS Version 6.1, VMScluster systems support the DS3 communications service to interconnect VMScluster systems. The DS3 service allows site-to-site cable route distances of up to 150 miles and delivers a bandwidth of 45 Mb/s in each direction.

The following chapters describe configuring and managing the DS3 communication service in multiple-site VMScluster systems.

2

Configuring VMScluster Systems for DS3 Communications

VMScluster systems running OpenVMS Version 6.1 support the use of the DS3 communications service to interconnect VMScluster systems. The DS3 service provides long-distance, point-to-point communications that you can configure into your VMScluster system to gain wide area network (WAN) connectivity. The DS3 service is available from most common telephone-service carriers and other sources. Note that DS3 service might not be available in all localities.

This chapter describes how to configure the DS3 communication service in multiple-site VMScluster systems.

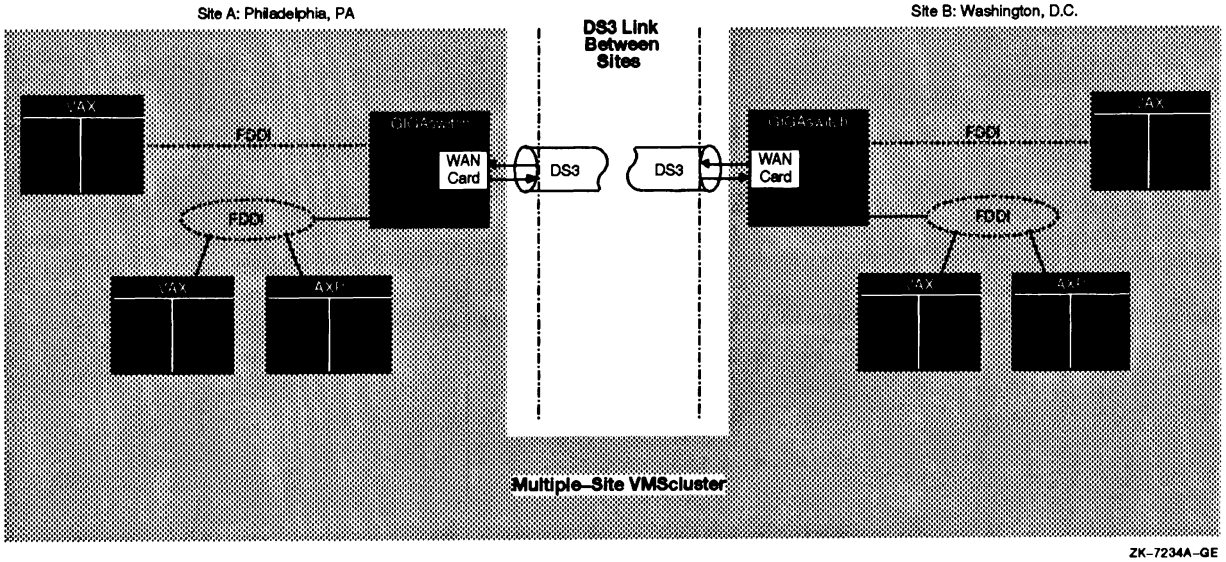
2.1 The DS3 Communications Service

The DS3 communications service provides full-duplex communications (that is, the bit rate is available simultaneously in both directions). DS3 provides the T3 standard bit rate of 45 Mb/s. T3 is the standard service available in North America and many other parts of the world. The availability of T3 may vary depending on your geographic location.

Digital recommends using the GIGAswitch system to construct FDDI to DS3 bridges. Digital used the GIGAswitch bridge, combined with the DEFGT WAN T3/SONET option card, during qualification testing of the DS3 communications service in VMScluster systems.

You can use FDDI-to-DS3 bridges to configure a VMScluster with members in geographically separate sites, such as the one shown in Figure 2–1. In the figure, the VMScluster nodes at each site communicate as though the two sites are connected by FDDI. Except for inherent DS3 performance characteristics, FDDI-to-DS3 bridges make the existence of DS3 transparent to the VMScluster software.

Figure 2–1 Multiple-Site VMScluster Configuration Connected by DS3



In Figure 2–1, the FDDI-to-DS3 bridges and DS3 operate as follows:

1. The local FDDI-to-DS3 bridge receives FDDI packets addressed to nodes at the other site.
2. The bridge converts the FDDI packets into DS3 packets and sends the packets to the other site via the DS3 link.
3. The receiving FDDI-to-DS3 bridge converts the DS3 packets into FDDI packets and transmits them on an FDDI ring at that site.

2.2 Guidelines for Configuring DS3 in a VMScluster System

When configuring a multiple-site VMScluster configuration with the DS3 interconnect, you must ensure that the DS3 delay, bandwidth, availability, and bit error rate characteristics meet application needs. The following describes the requirements and provides recommendations for meeting them.

Requirements: To be supported by Digital, a multiple-site VMScluster must comply with the following rules:

- Maximum DS3 route distance

  The total DS3 route distance between members of a multiple-site VMScluster cannot exceed 150 miles (242 km). You can obtain exact distance measurements from your DS3 supplier. *This distance restriction may be exceeded by Business Recovery Server configurations that meet Business Recovery Server configuration rules..*

- Maximum DS3 link utilization

  Average DS3 link utilization in either direction must be less than 80% of the link's bandwidth in that direction for any 10-second interval. Exceeding this utilization is likely to result in intolerable queuing delays or packet loss.

- DS3 link specifications

  The DS3 link must meet the VMScluster requirements specified in Table 2–3.

- VMScluster LAN configuration rules

  Apply the configuration rules for VMScluster systems on a LAN to a configuration. Documents describing configuration rules are referenced in Section 1.1.2.

Recommendations: When configuring the DS3 interconnect, apply the configuration guidelines for VMScluster systems interconnected by LAN that are stated in the cluster Software Product Descriptions (SPDs) and in the *Guidelines for VMScluster Configurations* manual. VMScluster members at each site can include any mix of satellites, systems, and other interconnects such as CI and DSSI. Additional configuration recommendations for multiple-site VMScluster systems are as follows:

- DS3 link capacity/protocols

  The GIGAswitch with the WAN T3/SONET option card provides several protocol options that can be used over a DS3 link. Use the DS3 link in clear channel mode, which dedicates its entire bandwidth to the WAN option card. The DS3 link capacity varies with the protocol option selected. Protocol options are described in Table 2–1:

Table 2–1 Protocol Options

Protocol Option	Link Capacity
ATM[1] AAL–5[2] mode with PLCP[3] disabled.	39 Mb/s
ATM AAL–5 mode with PLCP enabled.	33 Mb/s
HDLC[4] mode (not currently available).	43 Mb/s

[1]Asynchronous transfer mode

[2]ATM Adaptation Layer

[3]Physical Layer Convergence Protocol

[4]High-Speed Datalink Control

  For maximum link capacity, Digital recommends configuring the WAN T3/SONET option card to use ATM AAL–5 mode with PLCP disabled.

- Site-to-site bandwidth

  The performance of the DS3 link defines the bandwidth between the sites. The site-to-site bandwidth can limit application locking and I/O performance (including volume shadowing or RAID set copy times) and the performance of the lock manager.

  To ensure reasonable responsive time, Digital recommends that average traffic in either direction over a DS3 link not exceed 60% of the link's bandwidth in that direction for any 10-second interval. Otherwise queuing delays within the FDDI-to-DS3 bridges might impact application performance.

  Remember to account for both VMScluster communications (such as locking and I/O) and network communications (such as TCP/IP, LAT, and DECnet) when calculating link utilization.

- Site-to-site delay

  A DS3 link introduces a one-way delay of up to 1 ms per 100 DS3 route-distance miles plus the delays thru the FDDI-to-DS3 bridges at each end. Digital recommends that you consider the effects of intersite delays on application response time and throughput.

An I/O write operation that is MSCP served requires a minimum of two round-trip packet exchanges. Thus, an I/O write over a 100-mile DS3 link will take at least 4 ms longer than the same I/O write over a short, local FDDI. Each FDDI-to-DS3 bridge adds approximately an additional 0.5 ms, the total additional delay due to the DS3 link is 8 ms.

In addition, most lock operations mastered at a remote site require a round trip. Thus, an intersite lock operation over a 100-mile link requires an additional 2 ms.

- Bit error ratio

  The bit error ratio (BER) parameter is an important measure of how often bit errors are likely to occur on the DS3 link. You should consider the effects of bit errors on application throughput and responsiveness when configuring a multiple-site VMScluster. DS3 bit errors can result in packets being lost and retransmitted with consequent delays in application I/O response time (see Section 2.4). You can expect application delays ranging from a few hundred milliseconds to a few seconds each time a bit error causes a packet to be lost.

- DS3 link availability

  Interruptions of DS3 service can result in the resources at one or more sites becoming unavailable until DS3 connectivity is restored (see Section 2.3).

- System disks

  Sites with nodes contributing quorum votes should have a local system disk or disks for those nodes.

- System management

  A large, multiple-site VMScluster requires a system management staff trained to support an environment that consists of a large number of diverse systems that are used by many people performing varied tasks.

- Microwave DS3 links

  You can provide portions of a DS3 link with microwave radio equipment. The BER and availability of microwave radio portions of a DS3 link are affected by local weather and the length of the microwave portion of the link. Consider working with a microwave consultant who is familiar with your local environment if you plan to use microwaves as portions of a DS3 link.

2.3 Availability Considerations

Consider the following implications in the event that the FDDI-to-DS3 bridges and the DS3 link that connects multiple sites become unavailable:

- DS3 link failures can result in the resources at one or more sites becoming unavailable until DS3 connectivity is restored.
- DS3 bit errors and unavailability can affect:
  - System responsiveness
  - System throughput (or bandwidth)
  - Virtual circuit (VC) closure rate
  - VMScluster transition and site failover time

Many DS3 service carriers offer availability-enhancing options, such as path diversity, protective switching, and other options that can significantly increase the DS3 link's availability.

2.4 Specifications

This section describes the requirements for successful communications and performance with the DS3 communications service.

To assist you in communicating your requirements to a DS3 service supplier, this section uses specification terminology and definitions commonly used by telecommunications service providers. These requirements and goals are derived from a combination of Bellcore Communications Research specifications and a Digital analysis of error effects on VMSclusters.

Table 2–2 describes terminology that will help you understand the Bellcore and VMScluster requirements and goals used in Table 2–3.

Table 2–2 Bellcore and VMScluster Requirements and Goals

Specification	Requirements	Goals
Bellcore Communications Research	Bellcore specifications are the recommended "generic error performance requirements and objectives" documented in the Bellcore Technical Reference TR–TSY–000499 *TSGR: Common Requirements*. These specifications are sometimes adopted by T3 suppliers as their service guarantees. The FCC has also adopted them for tariffed services between common carriers. However, some suppliers will contract to provide higher service-quality guarantees at customer request. Europe and other countries have equivalents to the Bellcore specifications and parameters.	These are the recommended minimum values. Bellcore calls these goals their "objectives" in the *TSGR: Common Requirements* document.
VMScluster	In order for Digital to support a configuration, parameters must meet or exceed the values shown in the VMScluster Requirements column in Table 2–3.	For optimal VMScluster operation, all parameters should meet or exceed the VMScluster Goal values. *Note that if these values are met or exceeded, then interconnect bit errors and bit error recovery delays should not significantly degrade average VMScluster throughput. VMScluster response time should be generally satisfactory, although there may be brief application pauses a few times per day.*[2]

IF...	THEN...
These values are not met	VMScluster performance will probably be unsatisfactory because of interconnect errors/error recovery delays, and VC closures that may produce VMScluster state transitions and/or site failover.
These values are met or exceeded	Interconnect bit error–related recovery delays will not significantly degrade average VMScluster throughput. VMScluster response time should be generally satisfactory. *Note that if the requirements are only being met, there may be several application pauses per hour.* [1]

[1]Pauses are due to a virtual circuit retransmit timeout resulting from a lost packet on one or more NISCA transport virtual circuits. Each pause might last from a few hundred milliseconds to a few seconds.

[2]Application pauses may occur every hour or so (similar to what is described under VMScluster Requirements) because of packet loss caused by bit error.

Note

To ensure that the VMScluster system meets your application response-time requirements, you might need to establish DS3 requirements that exceed the Bellcore and VMScluster requirements and goals stated in Table 2–2.

Use the Bellcore and VMScluster requirements for DS3 service error performance (quality) specified in Table 2–3 to help you assess the impact of the DS3 service supplier's availability, down time, and service-interruption frequency goals on the system.

Table 2–3 VMScluster DS3 Error Performance Requirements

Parameter	Bellcore Requirement	Bellcore Goal	VMScluster Requirement[1]	VMScluster Goal[1]	Units
Errored seconds (% ES)	<1.0%	<0.4%	<1.0%	<0.028%	% ES/24 hr
The ES parameter can also be expressed as a count of errored seconds, as follows:					
	<864	<345	<864	<24	ES per 24-hr period
Burst errored seconds (BES)[2]	≤4	–	≤4	Bellcore Goal	BES/day
Bit error ratio (BER)[3]	1×10^{-9}	2×10^{-10}	1×10^{-9}	6×10^{-12}	Errored bits/bit
Channel unavailability	None	≤97 @ 250 miles, linearly decreasing to 24 @ ≤25 miles	None	Bellcore Goal	Min/yr
Channel unavailable event[4]	None	None	None	1 to 2	Events/year

[1]Application requirements might need to be more rigorous than those shown in the VMScluster Requirements column.

[2]Averaged over many days.

[3]Does not include any burst errored seconds occurring in the measurement period.

[4]The average number of channel downtime periods occurring during a year. This parameter is useful for specifying how often a DS3 channel might become unavailable.

Table Key

- Availability—The long-term fraction or percentage of time that a transmission channel performs as intended. Availability is frequently expressed in terms of unavailability or down time.
- BER (bit error ratio)—"The BER is the ratio of the number of bits in error to the total number of bits transmitted during a measurement period, excluding all burst errored seconds (defined below) in the measurement period. During a burst errored second, neither the number of bit errors nor the number of bits is counted."
- BES (burst errored second)—"A burst errored second is any errored second containing at least 100 errors."
- Channel—The term for a link that is used in the Bellcore *TSGR: Common Requirements* document for a DS3 link.
- Down time—The long-term average amount of time (for example, minutes) that a transmission channel is not available during a specified period of time (for example, 1 year).

  "...unavailability or downtime of a channel begins when the first of 10 [or more] consecutive Severely Errored Seconds (SESs) occurs, and ends when the first of 10 consecutive non-SESs occurs."

  The unavailable time is counted from the first SES in the 10–SES sequence.

  "The time for the end of unavailable time is counted from the first fault-free second in the [non-SES] sequence."
- ES (errored second)—"An errored second is any one-second interval containing at least one error."
- SES (severly errored second)—"...an SES is a second in which the BER is greater than 10^{-3}."

3

Managing VMScluster Systems Across Multiple Sites

In general, you manage a multiple-site VMScluster using the same tools and techniques that you would use for any VMScluster interconnected by a LAN. This chapter describes some additional considerations and recommends some system management tools and techniques.

3.1 System Management Considerations

The following table lists system management considerations specific to multiple-site VMScluster systems.

Problem	Possible Solution
Multiple-site configurations present an increased probability of the following failure modes: • VMScluster quorum loss resulting from site-to-site communication link failure. • Site loss resulting from power failure or other breakdown can affect all systems at that site.	Assign votes so that one preferred site has sufficient votes to maintain quorum and to continue operation if the site-to-site communication link fails or if the other site is unavailable. Select the site with the most critical applications as the primary site. Sites with a few noncritical systems or satellites probably should not have sufficient votes to continue.
Users expect that the local resources will either continue to be available or will rapidly become available after such a failure. This might not always be the case.	Consider some of the following options for setting user expectations: • Set management and user expectations regarding the likely effects of failures, and consider training remote users in the procedures to be followed at a remote site when the system becomes unresponsive because of quorum loss or other problems. • Develop management policies and procedures for what actions will be taken to identify and handle these failure modes. These procedures may include manually adjusting quorum to allow a site to continue.

3.2 Methods and Tools

You can use the following system management methods and tools to manage both remote and local nodes:

- There are two options for remote-site console access when you use a DS3 through a DECserver in reverse LAT mode.
  1. Use the following tools to connect remote consoles:
     - SET HOST/LAT command
     - POLYCENTER Console Manager
     - VMScluster Console System (VCS)
     - Business Recovery Server Operations Management Station (includes VCS)
  2. Use a modem to dial up the remote system consoles.
- An alternative to remote-site console access is to have a system manager at each site.
- To enable device and processor control commmands to take effect across all nodes in a VMScluster system, use the System Management utility (SYSMAN) that is supplied with the OpenVMS operating system.

3.3 Shadowing Data

Volume Shadowing for OpenVMS allows you to shadow data volumes across multiple sites. System disks can be members of a volume shadowing or RAID set within a site; however, system-disk volume shadowing or a RAID set should not have members at both sites. This is because systems at a failed site may not be able to reboot and join a VMScluster that has continued or has been restarted at the other site.

See the Software Product Descriptions (SPDs) for complete and up-to-date details about Volume Shadowing for OpenVMS and StorageWorks RAID for OpenVMS.

3.4 Monitoring Performance

Monitor performance for multiple-site VMScluster systems as follows:

- Monitor the virtual circuit (VC) packet-loss count and round-trip time values using the System Dump Analyzer (SDA). The procedures for doing this are documented in *VMScluster Systems for OpenVMS*.
- Monitor the site-to-site DS3 link bit error ratio (BER) and packet loss using network management tools. You can use tools such as POLYCENTER NetView or DECmcc to access the GIGAswitch and WAN T3/SONET option card's management information and to set alarm thresholds. See the GIGAswitch, WAN T3/SONET card, POLYCENTER, and DECmcc documentation, as appropriate.

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Figures (useful)	☐	☐	☐	☐
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